Countering Weapons of Mass Destruction

S&T Architecture for Controlling Nuclear Materials

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CWMD PSC Membership

NCB/NM	Greg Simonson (Chair)
NCB/NM	Michaela Eddy
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Army	Eric Zimmerman
Navy	William Thompson
Air Force	Mark Fagan
OUSD(P)	Jessica Cox
OUSD(I)	Michael Spence
DTRA	Tony Pang
DTRA	Stephanie Vaughn
JASONs	

"We must ensure that terrorists never acquire a nuclear weapon. This is the most immediate and extreme threat to global security."
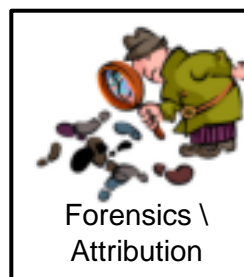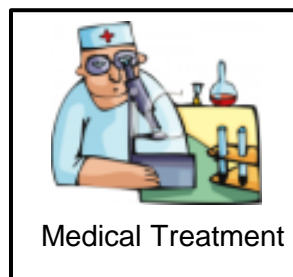
President Obama, Prague, Czech Republic, April 5, 2009

Scope of CWMD Challenge Problem

Reduce & Secure

Locate & Monitor

Track

Challenge Problem

Interdict / Defeat

Tactical Warning

Characterization \ Decision-Making

Hardening

Medical Pretreatment

Detonation / Release

Medical Treatment

Forensics \ Attribution

Consequence Management

Restoration

Systems Performance Goals

- Broad Area Search
- Persistent Monitoring
- Tagging and Tracking

Technical Challenges

- Systems Integration
- Activity Recognition
- Advanced Signature Detection & Tracking
- Advanced Radiation Detection

CWMD Problem Statement

Scenario: Imminent theft of nuclear weapon from a foreign storage facility by terrorist cell with insider assistance

- **The U.S. needs improved capability to deal with a potential future "loose nuke" emergency involving a foreign nuclear weapon or significant amount of special nuclear material (SNM)**
  - **Earlier cue that a plot is afoot or a theft has occurred**
  - **Faster access to the area**
  - **Improved monitoring ability and TTL**
  - **Higher confidence in containment and search**
- **Radiation detectors alone will not solve the problem**
  - **Persistent range constraint; emplacement; shielding…**
- **ISR technologies, lower latency, networks of networks, and social media may be part of the solution**

What S&T investments are central to loose nuke problem and in what architecture would new technologies be deployed?

Loose Nukes Parameter Space

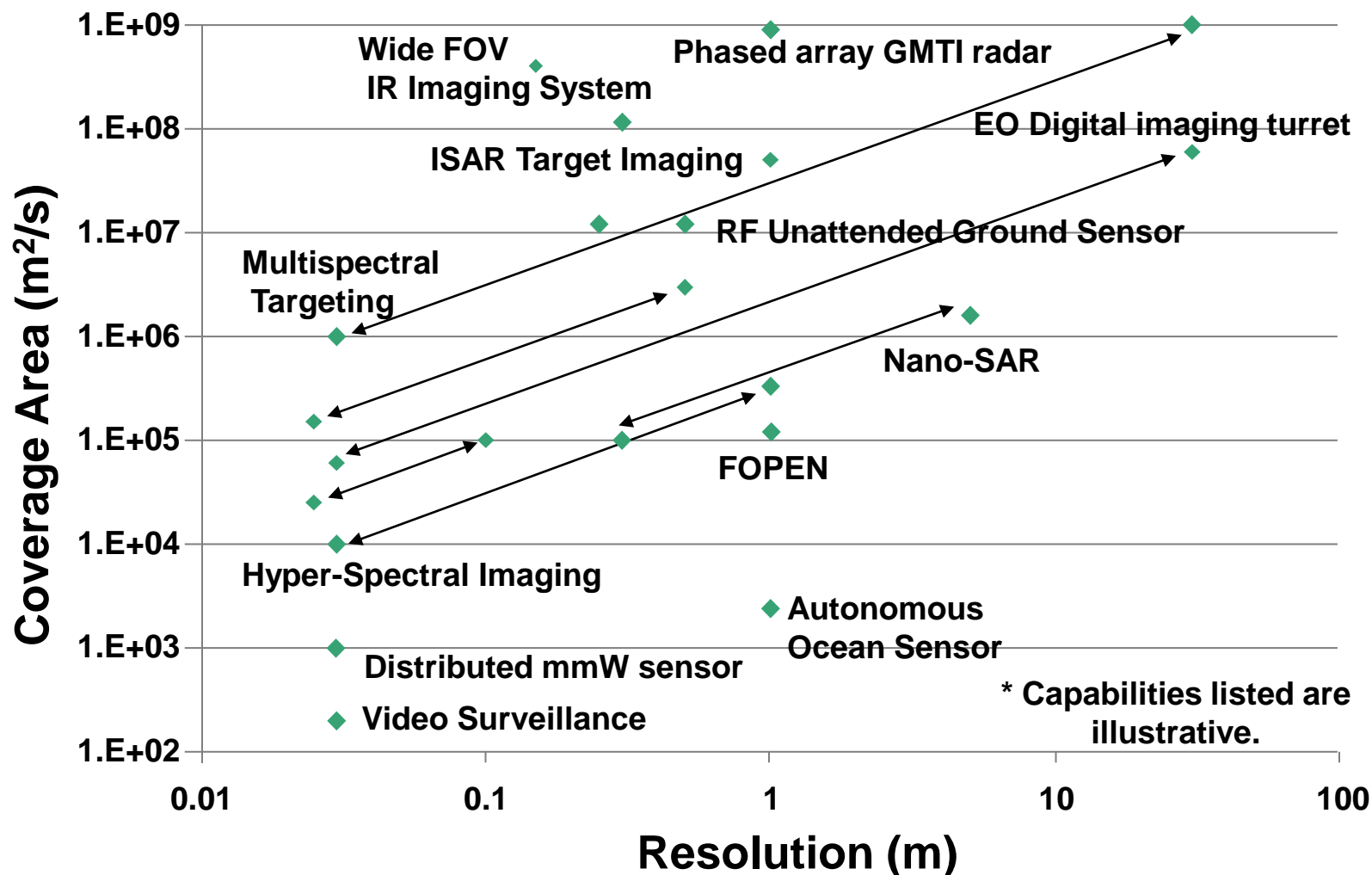|	Technical Challenge	Objectives	Technical Approach
3-5 years	**Existing data fusion**	**CWMD community in complete concert**	**Global CWMD Analysis System; sensor fusion**
5-7 years	**Alternate signature exploitation**	**Locate, monitor and track WMD at strategic distances**	**HSI, IR, FTIR, GPS, radar, lidar, RFID, nanoparticles, etc.**
7-10+ years	**All-source Information Integration**	**Pre-event cues, real-time activity detection**	**Net-networks; beyond physics sensing**

Parameter Space: Signatures

Target Class: Vehicle

<u>Sub-Class:</u> Passenger Car, Light Truck, Heavy Truck, APC, Tank

Observable	Signature	Sensor
color	absorbance	HSI
material	reflectance	HSI
heat	thermal gradient	IR
chem emission	hydrocarbons	FTIR/chem
size	pixels/return/reference scale	EO/radar
motion	doppler/angular change/GMTI/GPS*	Radar/lidar/FMV
weight	seismic/magnetic	geophone/accelerometer/ magnetometer
sound	acoustic/seismic	microphone/accelerometer
Location	Georeference/GPS	EO/SIGINT
EM	EM	EM (inductive/capacitive)
RF	RF	RFI/DF

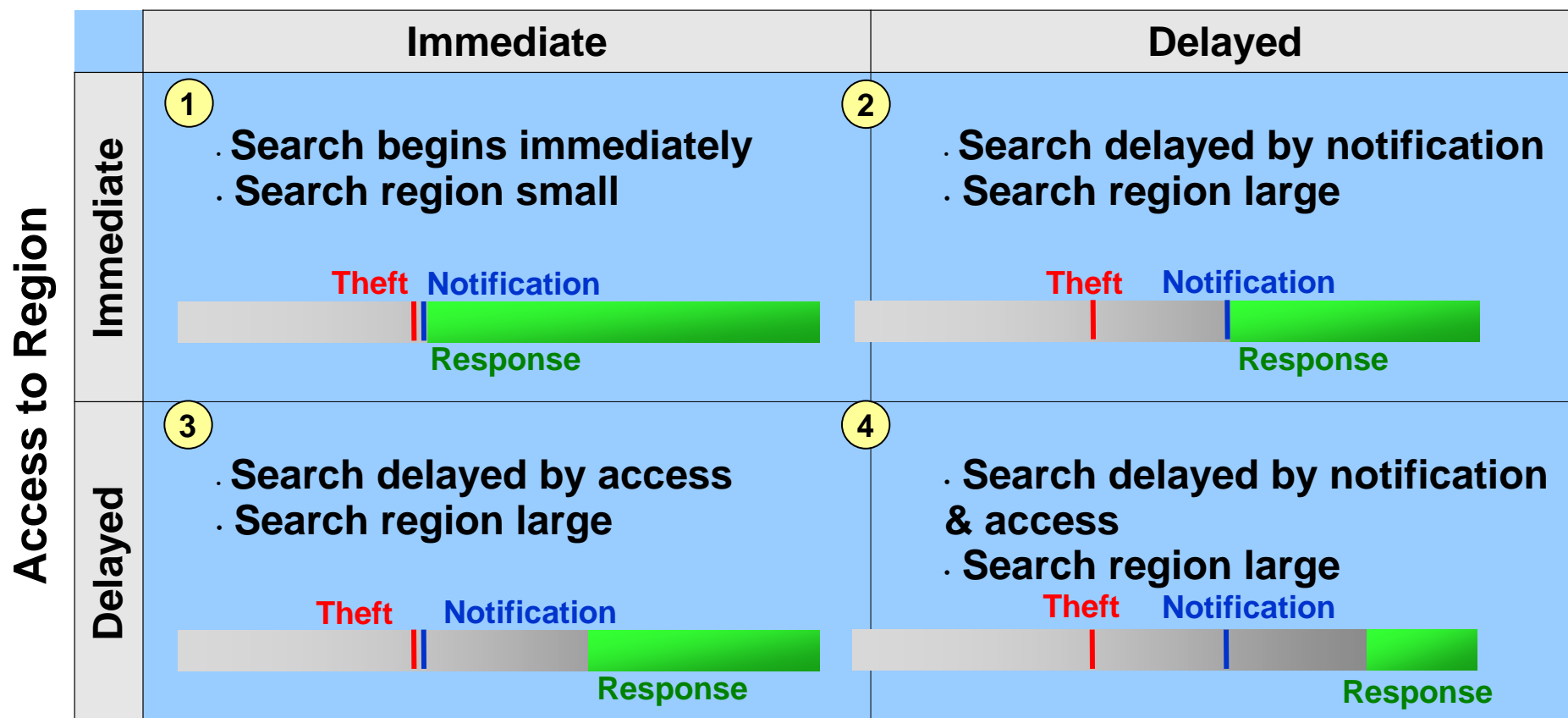## And similar sets for payloads, people, facilities, sites…

Parameter Space: Sensors

Source: The Technical Cooperation Program

Parameter Space: Architecture

Notification of "Theft"

	Immediate	Delayed
Immediate (Access to Region)	**1** · **Search begins immediately** · **Search region small**	**2** · **Search delayed by notification** · **Search region large**
Delayed (Access to Region)	**3** · **Search delayed by access** · **Search region large**	**4** · **Search delayed by notification & access** · **Search region large**

Access to Region

1 Theft — Notification — Response

2 Theft — Notification — Response

3 Theft — Notification — Response

4 Theft — Notification — Response

- **Delays in response to theft (caused by late notification or access) increase the "level of difficulty" in recovering SNM**

Technical Challenges & Metrics

	Today	10 yrs
• **Confidence in getting a cue**	**<10%**	**>>50%**
• Sense change in SNM/NW state	Low	High
• SNM rad detection (m)	<10	100
• Alt signature readiness	Fair	Good
• **Sensor deployment latency**	**days**	**<hour**
• Sensor handoff	Poor	Perfect
• **Data/network fusion**	**<10%?**	**100%**
• Persistent surveillance (km^2)	100s	10,000s
• Tracking confidence	Low	High
• Broad area search (km^2/hr)	<10	1,000s
• Behavior/intent detection	Low	High
• **Social network exploitation**	**<10%**	**>>50%**
• **Architecture maturity**	**Low**	**High**

Notional

CWMD "Loose Nukes" Roadmap

Needed Operational Capabilities

Pre-Positioned Assets, Intel Fusion, Cue, Containment, Locate, Recover

Technology Development Areas

Rad Detection   Persistent Monitoring/ISR   TTL BAS   Intent/Behavior   Architecture

Science and Technology Development

FY 15-17	FY 17-19	FY 19-22+
Systems Integration	**Advanced Signature Detection**	**All-Source Information Integration**
Activity Recognition	**Advanced Tracking**	**Advanced Signature Detection and Tracking**
Integration of all-source intel and human reasoning, multi-sensor **data fusion**, pathway analysis, automated behavioral analysis	HSI, IR, FTIR, radar, lidar, RF, FMV, GPS, accelerometers, RFID, reduced data latency, **network fusion**	Integration algorithms, matrixed detectors, networks of networks, beyond physics: social network analysis, **automated all-source information fusion**

Revolving integration, demonstration and transition to meet operational needs

Note: These are not currently funded initiatives

Big Gaps: Opportunities for NDIA

- **Next gen rad detection, e.g. nanomaterials; ionized air; HSI**
- **Alternate signatures related to weapon activity**
  - **People, programs, communications, facilities, behaviors…**
- **Persistent intelligence, surveillance and reconnaissance**
  - **Sensor development and platform integration**
  - **Technical, intelligence and social data fusion**
- **Data-to-Decision Tools**
  - **Next-generation reachback and information sciences capabilities**
  - **High performance computing**
- **Architectures for prompt access and low latency**
- **Beyond physics**
  - **Human behavior and intent detection**
  - **Social network analysis**
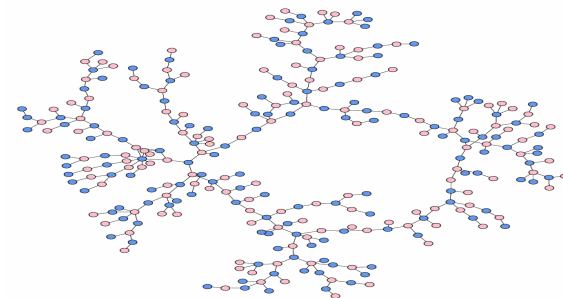
BAAs and SBIRs

BAAs:

ARL Postdoc Fellowship Program	W911NF-11-R-0010
RDECOM-STTC	W91CRB-08-R-0073
ARO	W911NF-07-R-0003-04
ARL/ARO	W911NF-07-R-0001-05
DARPA	DARPA-11-34: I2O Office-Wide BAA
AFOSR	AFOSR-BAA-2009-1
AFOSR	AFOSR-BAA-2011-01
DHS	DHSS-TLRBAA11-03
DTRA	HDTRA1-11-16-RDIS-BAA
DTRA	HDTRA1-11-16-BRCWMD-BAA
ONR	BAA 12-001

also Special Notice 11-SN-0004 under this BAA, titled "Data to Decision"

SBIRs:

Army: https://www.armysbir.army.mil/default.aspx

DoD: http://dodsbir.net/solicitation/default.htm

CWMD Summary

- **Capability against loose nukes needs improvement**
  - **There is no silver bullet**
  - **Heavy reliance on early cue**
- **Radiation detection alone is not enough**
- **Many other signatures/sensors can be brought to bear**
  - **Substantial capability already exists**
  - **But data needs to be integrated**
- **Sensor handoff/sensor fusion/network fusion essential**
- **Opportunities in ISR for persistent surveillance, tracking, and broad area search in scenario-specific architectures**
- **Greatest gains may be in automating synthesis of sensor data, intel analysis, all networks including social networks, and non-physics based detection of behavior and intent**